9 Quality Assurance Procedures

Random Numbers

Design Mix Formula

Lot/Sublot -- QC/QA HMA and SMA

Acceptance Samples

Adjustment Period -- QC/QA HMA and SMA

Mixture Acceptance

- ***QC/QA HMA***
- ***HMA***
- ***SMA***

Density Acceptance

Smoothness Acceptance

Pay Factors -- QC/QA HMA

- ***Mixture***
- ***Density***

Mix Appeal -- QC/QA HMA

Adjustment Quantity -- QC/QA HMA

Adjustment Quantity -- SMA

Mixture Adjustment Factor

CHAPTER NINE: QUALITY ASSURANCE PROCEDURES

The acceptance criteria for QC/QA HMA set out in the Quality Assurance Specifications are based on binder content, air voids, Voids in the Mineral Aggregate (VMA), density, and smoothness. The Standard Specifications establish controls for temperature and moisture content of the mixture, testing of aggregates for quality, and testing of binder. The acceptance criteria for HMA mixtures are based on binder content, and air voids. The acceptance criteria for SMA mixtures are binder content, and gradation.

This section includes the procedures for obtaining acceptance samples, minimum requirements for mixture properties in accordance with Sections **401** (QC/QA HMA)**, 402** (HMA)**,** and **410** (SMA), and the procedures for determining pay factors.

RANDOM NUMBERS

Sampling for mixture tests is done on a random basis using **ITM 802.** A table of Random Numbers as shown on Form TD-458 (Figure 9-1), is used to determine the random quantity or random location. The numbers occur in this table without aim or reason and are in no particular sequence. Therefore, samples obtained by the use of this table are truly random or chance, and eliminate the technician's bias in obtaining samples.

To use this table to determine the random ton to sample, select without looking one block in the table. After selecting the block, the top left number in the block is the first random number used. This number will be the beginning number. Proceed down the column for additional numbers and proceed to the top of the next column on the right when the bottom of the column is reached. When the bottom of the last column on the right is reached, proceed to the top of the column at the left. If all numbers in the table are used, select a new starting number and proceed in the same manner.

To use this table to determine the location of the pavement sample, again select a block in the table and start with the top left number. This number will be used to determine the test site station. The adjacent number within the block will be used to determine the transverse distance to the random site. Proceed down by pairs until the bottom numbers are reached and proceed to the adjacent top block to the right, if available. When the bottom pair of numbers on the right are reached, proceed to the top block on the left in the table.

TD-458

RANDOM NUMBERS

.576	.730	.430	.754	.271	.870	.732	.721	.998	.239
.892	.948	.858	.025	.935	.114	.153	.508	.749	.291
.669	.726	.501	.402	.231	.505	.009	.420	.517	.858
.609	.482	.809	.140	.396	.025	.937	.310	.253	.761
.971	.824	.902	.470	.997	.392	.892	.957	.040	.463
.053	.899	.554	.627	.427	.760	.470	.040	.904	.993
.810	.159	.225	.163	.549	.405	.285	.542	.231	.919
.081	.277	.035	.039	.860	.507	.081	.538	.986	.501
.982	.468	.334	.921	.690	.806	.879	.414	.106	.031
.095	.801	.576	.417	.251	.884	.522	.235	.389	.222
.509	.025	.794	.850	.917	.887	.751	.608	.698	.683
.371	.059	.164	.838	.289	.169	.569	.977	.796	.996
.165	.996	.356	.375	.654	.979	.815	.592	.348	.743
.477	.535	.137	.155	.767	.187	.579	.787	.358	.595
.788	.101	.434	.638	.021	.894	.324	.871	.698	.539
.566	.815	.622	.548	.947	.169	.817	.472	.864	.466
.901	.342	.873	.964	.942	.985	.123	.086	.335	.212
.470	.682	.412	.064	.150	.962	.925	.355	.909	.019
.068	.242	.777	.356	.195	.313	.396	.460	.740	.247
.874	.420	.127	.284	.448	.215	.833	.652	.701	.326
.897	.877	.209	.862	.428	.117	.100	.259	.425	.284
.876	.969	.109	.843	.759	.239	.890	.317	.428	.802
.190	.696	.757	.283	.777	.491	.523	.665	.919	.146
.341	.688	.587	.908	.865	.333	.928	.404	.892	.696
.846	.355	.831	.218	.945	.364	.673	.305	.195	.887
.882	.227	.552	.077	.454	.731	.716	.265	.058	.075
.464	.658	.629	.269	.069	.998	.917	.217	.220	.659
.123	.791	.503	.447	.659	.463	.994	.307	.631	.422
.116	.120	.721	.137	.263	.176	.798	.879	.432	.391
.836	.206	.914	.574	.870	.390	.104	.755	.082	.939
.636	.195	.614	.486	.629	.663	.619	.007	.296	.456
.630	.673	.665	.666	.399	.592	.441	.649	.270	.612
.804	.112	.331	.606	.551	.928	.830	.841	.702	.183
.360	.193	.181	.399	.564	.772	.890	.062	.919	.875
.183	.651	.157	.150	.800	.875	.205	.446	.648	.685

Figure 9-1. Random Numbers

DESIGN MIX FORMULA

The Producer is required to submit for the approval of the PE/PS, a Design Mix Formula (DMF) for each mixture. This information is recorded in a format acceptable to the Engineer. TD-451 is one format that has been used for this purpose. (Figure 9-2). INDOT is required to have a copy of the DMF prior to production of any mixture.

LOT/SUBLOT -- QC/QA HMA and SMA

Quality Assurance Specifications consider a lot as 4000 tons of base or intermediate QC/QA HMA, and 2400 tons of surface QC/QA HMA or SMA. The lots are divided into four sublots of equal tons. For base and intermediate QC/QA HMA therefore a sublot is 1000 tons, and for surface QC/QA HMA or SMA, a sublot is 600 tons. Partial sublots of 100 tons or less are added to the previous sublot. Partial sublots greater than 100 tons constitute a full sublot.

ACCEPTANCE SAMPLES

Sampling of mixture for acceptance is made from the pavement in accordance with **ITM 580**. INDOT determines the random site and the Contractor obtains the samples under INDOT supervision.

A specific ton in each sublot is selected and the mixture from the truck containing that ton is sampled. This truck is determined by checking the weigh tickets. An example of how to determine what ton is to be sampled is shown on form TD-452 (Figure 9-3). These random tons are not shown to the Contractor so that there will be no possible influence on the construction operations.

Once the truck that contains the random ton is identified, the approximate total length of mixture that the truck will place is determined by knowing the weight of the truck, the paving width, and the quantity placed. When placing variable depth, such as a crown correction, the average depth should be used. The following relationship is used to calculate this approximate length.

$$\text{Length of Load (Nearest Foot)} = \frac{\text{Load Weight (t)}}{\text{Avg. Planned Quantity } (\text{lb/yd}^2) \times \text{Width of Paving (ft)}} \times 18000$$

State Form XXXXX (R3/07-2002)

INDIANA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TEST DIVISION

SUPERPAVE DMF/JMF COVERSHEET

CONTRACTOR: J. Wooden Const.
MIX PRODUCER: J. Wooden Const.
PLANT LOCATION: W. Lafayette
PLANT NO.: 3550
MIX DESIGN LAB: 0149

DATE: 7-21-02
CONTRACT: R-3000
ROAD NO.: I-65
DISTRICT: Crawfordsville
REF. JMF: ____ (Contract) ____ (JMF No.)

MATERIAL SOURCES

COARSE AGG. (SOURCE & LEDGE):
2421 - Ledges 1-5, #8's
2421 - Ledges 1-5, #11's

FINE AGG. (NAT./MAN. & SOURCE):
2421 - Ledges 1-5

PG BINDER (TYPE & SOURCE):
PG 70-22, 7101

ANTI-STRIP AGENT & DOSAGE RATE:
None Required

DESIGN MIX FORMULA / JOB MIX FORMULA

DMF/JMF number	0110133	
Material code	3222	
ESAL	15,000,000	
Mixture type	19.0 mm Int.	
Maximum particle size	1 in.	
	MASS	VOLUME
% Pass 1 1/2 in.		
% Pass 1 in.	100	
% Pass 3/4 in.	95.3	
% Pass 1/2 in.	81.0	
% Pass 3/8 in.	——	
% Pass No. 4	——	
% Pass No. 8	25.0	
% Pass No. 30	10.5	
% Pass No. 200	4.2	
Gsb	2.682	
Mix temperature min. °F	260	
Mix temperature max °F	325	
RAP % in mixture	0	
RAP binder % extracted	—	

Ignition oven test temp. °F	1000
Ignition oven calibration factor	0.42
Ignition oven serial number	21
Binder % actual (ig. ov.)	4.5
Binder % extracted	4.3
MSG w/ dry back Yes or No	No
Gyrations Nini/Ndes/Nmax	8/100/100
Density, kg/m^3 @ Ndes	151.6
Gmb (plot/calculate) @ Nmax	2.480
Gmm (plot/calculate)	2.538
% Air voids @ Ndes	4.3
VMA @ Ndes	13.5
VFA @ Ndes	68.1
Coarse aggregate angularity	——
Fine aggregate angularity	48.0
Sand equivalency	85.0
Dust/calculated effective binder	1.00
Tensile strength ratio	86.9

CONTRACTOR SIGNATURE: _____ DATE: _____

DMTE OR PE SIGNATURE: _____ DATE: _____

Figure 9-2. Design Mix Formula

TD-452 State Form 36667 (R3/3-95)

COPIES TO:
DISTRICT TESTING ENGINEER
FILE

INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS

RANDOM SAMPLING FOR MIX ANALYSIS

Contract No. R-20396 LOT No. 4

District Greenfield Mixture 19.0 mm Intermediate

DATE SAMPLED: SUBLOT 1 6/9/01 SUBLOT 2 6/9/01 SUBLOT 3 6/10/01 SUBLOT 4 6/10/01

SUBLOT NO.	SUBLOT TONS	RANDOM NO.	RANDOM TON	LOT TON TO BE SAMPLED		PAVING WIDTH	RANDOM NO.	TRANS. LOC.	LENGTH OF LOAD	RANDOM NO.	RANDOM DIST.	STARTING STA.*	RANDOM STATION
	A	B	A x B = C	D	C + D	E	F	E x F	G	H	G x H = I	J	I + J
1	600			0									N.B. Passing
	1000	.123	123	0	123	12	.100	1.2 (1)	136	.259	35	10+50	10+85
2	600			625									N.P. Passing
	1000	.116	116	1000	1116	12	.890	10.7 (11)	136	.317	43	76+90	77+33
3	600			1250									N.B. Passing
	1000	.836	836	2000	2836	12	.523	6.3 (6)	136	.665	90	194+00	194+90
4	600			1875									N.B. Passing
	1000	.636	636	3000	3636	12	.928	11.1 (11)	136	.404	55	247+20	247+75

* *STATION OF PAVER WHEN TRUCK CONTAINING RANDOM TON BEGINS UNLOADING.*

$$\textit{Length of Load} = \frac{\text{Load Weight (tons)}}{\text{Avg. Planned Quantity (lb./sq. yd.)} \times \text{Width of Paving (ft.)}} \times 18000$$

(Nearest Foot)

Signed _____

Figure 9-3. Random Sampling for Mix

The length the truck will place is multiplied by the first random number to obtain a longitudinal distance. This distance is measured from the location of the paver when the truck containing the random ton begins unloading into the paver or material transfer device. The transverse test site location is determined by multiplying the width of pavement by the second random number and rounding to the nearest whole foot. This distance is measured from the right edge of pavement when looking in the direction of increasing station numbers. If the transverse location is less than 1 ft from either edge of pavement, at a location where the course thickness is less than 2.0 times the maximum particle size, or within the width of the roller drum used to form shoulder corrugations, then another random location is selected to obtain an acceptable sampling location. The following example shows how these random locations are determined.

Example

Width of Pavement	= 12 ft
Load Weight	= 20 t
Mixture	= 9.5 mm Surface
Planned Quantity	= 110 lb/yd^2
Ending Station of Paver of Previous Load	= 158+00
Random Numbers	= .256, .561

Test Site Station

$$\text{Length of Load} = \frac{20}{110 \times 12} \times 18000 = 273 \text{ ft}$$

Longitudinal Distance = 273 x .256 = 70 ft
Random Station = (158+00) + 70 = 158+70

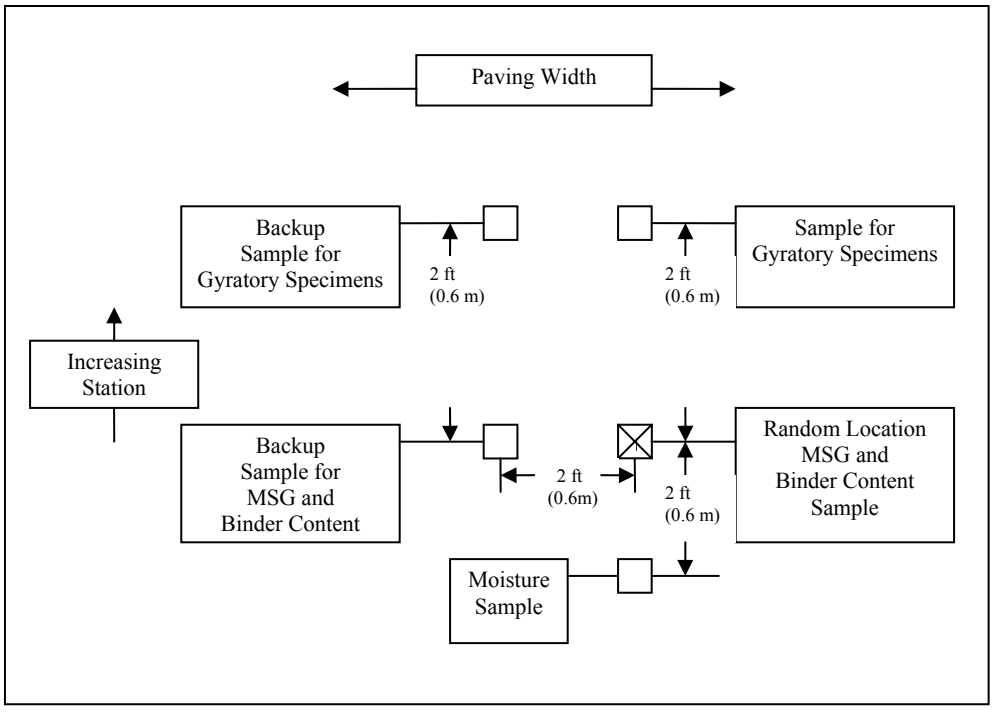
Transverse Distance

Distance = 12 x .561 = 6.7 ft (say 7 ft)

For contracts controlled by volumetrics in accordance with Section **401** additional samples are required. The first plate sample location is determined by the random sampling procedure and this material is used for the maximum specific gravity and binder content samples. A second plate sample is placed longitudinally 2 feet upstation from the first plate at the same transverse offset. This sample is used for the gyratory specimens. For a QC/QA HMA surface mixture, a moisture sample is required. A third plate for the moisture sample is placed longitudinally 2 feet backstation from the first plate at the same transverse offset.

If an appeal by the Contractor of the INDOT test results is accepted, backup samples are tested. These samples are obtained at the same time as the acceptance samples. The backup sample plate for the maximum specific gravity and binder content is placed transversely 2 feet from the first plate towards the center of the mat. The backup sample for the gyratory specimens is placed transversely 2 feet from the second plate towards the center of the mat.

The following diagram shows an example of an arrangement of the plate samples when additional samples are required:



Using the previous example, the sample locations are determined as follows:

MSG and Binder Content Sample
Random Location = 158 + 70
Transverse Distance = 7 ft

Gyratory Specimens Sample
Random Location = (158 + 70) + 02
= 158 + 72

Transverse Location = 7 ft

Moisture Sample (Surface Mixture Only)
Random Location = (158 + 70) - 02
= 158 + 68
Transverse Location = 7 ft

Backup Sample for MSG and Binder Content
Random Location = 158 + 70
Transverse Distance = 7-2
= 5 ft

Backup Sample for Gyratory Specimens
Random Location = (158 + 70) + 2
= 158 + 72
Transverse Distance = 7-2
= 5 ft

The size of the plate used to obtain a sample is dependent on the test (s) conducted on the material. The following minimum sample weights are required:

Mixture Designation	Minimum Weights (g)		
	Moisture	MSG and Binder Content	Gyratory Specimens
4.75 mm	1000	1200	11,000
9.5 mm	1500	3000	11,000
12.5 mm	2000	4000	11,000
19.0 mm, OG 19.0 mm	3000	5500	11,000
25.0 mm, OG 25.0 mm	4000	7000	11,000

Included below are the approximate weights that may be obtained for various sizes of plates and lift thicknesses that are placed:

Approximate Sample Yield for Various Lift Thickness and Plate Sizes								
Lift Thickness	**Lay Rate**	**Plate Size, inches**						
Inches	**lb/yd^2**	**8**	**9**	**10**	**11**	**12**	**14**	**16**
		Sample Weight (g)						
1.25	137.5	3100	3900	4800	5900	7000	9500	12400
1.5	165	3700	4700	5800	7000	8400	11400	14900
1.75	192.5	4300	5500	6800	8200	9800	13300	17300
2.0	220	5000	6300	7700	9400	11100	15200	19800
2.25	247.5	5600	7100	8700	10500	12500	17100	22300
2.5	275	6200	7800	9700	11700	13900	19000	27800
2.75	302.5	6800	8600	10600	12900	15300	20900	27300
3.0	330	7400	9400	11600	14100	16700	22800	29700
3.25	357.5	8100	10200	12600	15200	18100	24700	32200
3.5	385	8700	11000	13500	16400	19500	26600	34700
3.75	412.5	9300	11800	14500	17600	20900	28500	37200
4.0	440	9900	12500	15500	18700	22300	30300	39600
4.25	467.5	10500	13300	16400	19800	23600	32100	41900
4.5	495	11100	14000	17300	21000	25000	34000	44400
4.75	522.5	11700	14800	18300	22100	26400	35900	46900
5.0	550	12300	15600	19300	23300	27700	37800	49300
5.25	577.5	12900	16400	20200	24500	29100	39700	51800
5.5	605	13600	17200	21200	25600	30500	41500	54300
5.75	632.5	14200	17900	22200	26800	31900	43400	56700
6.0	660	14800	18700	23100	28000	33300	45300	59200

When a mold is used with the plate, the approximate weights that may be obtained for various sizes of molds and lift thicknesses are as follows:

Approximate Sample Yield for Various Lift Thickness and Mold Sizes						
Lift Thickness	**Lay Rate**	**Mold Size, inches**				
Inches	**lb/yd²**	**8**	**10**	**12**	**14**	**16**
		Sample Weight (g)				
1.25	137.5	2400	3800	5400	7400	9700
1.5	165	2900	4500	6500	8900	11600
1.75	192.5	3400	5300	7600	10400	13600
2.0	220	3900	6100	8700	11900	15500
2.25	247.5	4400	6800	9800	13300	17400
2.5	275	4800	7600	10900	14800	19400
2.75	302.5	5300	8300	12000	16300	21300
3.0	330	5800	9100	13100	17800	23200
3.25	357.5	6300	9800	14200	19300	25200
3.5	385	6800	10600	15300	20800	27100
3.75	412.5	7300	11300	16300	22200	29100
4.0	440	7700	12100	17400	23700	31000
4.25	467.5	8200	12900	18500	25200	32900
4.5	495	8700	13600	19600	26700	34900
4.75	522.5	9200	14400	20700	28200	36800
5.0	550	9700	15100	21800	29700	38700
5.25	577.5	10200	15900	22900	31100	40700
5.5	605	10700	16600	24000	32600	42600
5.75	632.5	11100	17400	25100	34100	44500
6.0	660	11600	18200	26100	35600	46500

ADJUSTMENT PERIOD -- QC/QA HMA and SMA

The Producer is allowed an adjustment period for each mix design in which the mix design is verified and changes may be made in the DMF, if necessary. A job mix formula (JMF) is submitted for approval to the PE/PS upon completion of the adjustment period. The adjustment period is from the beginning of production and extending until 4000 tons of base or intermediate QC/QA HMA, or 2400 tons of surface QC/QA HMA or SMA has been produced for each mix design. A reduced adjustment period is allowed. If production extends into the next construction season, another adjustment period is allowed.

MIXTURE ACCEPTANCE

QC/QA HMA

Acceptance of QC/QA HMA mixtures for binder content, VMA at N_{des}, and air voids at N_{des} for each lot is based on tests conducted by INDOT. Acceptance testing for surface mixtures includes tests for moisture content. INDOT randomly selects the location(s) within each sublot for sampling in accordance with the **ITM 802.**

Samples from the pavement are obtained from each sublot in accordance with **ITM 580**. The test results for each sublot are required to meet the requirements for the tolerances from the JMF as shown in the table as follows:

ACCEPTANCE TOLERANCES	
MIXTURE PROPERTIES	TOLERANCES FROM JMF
DENSE GRADED	
Air Voids	JMF ± 1.0%
Binder Content	JMF ± 0.5%
VMA	JMF ± 1.0%
OPEN GRADED	
Air Voids *	JMF ± 3.0%
Binder Content	JMF ± 0.5%

* Gmb will be determined in accordance with **ASTM D 6752**

The maximum percent of moisture in the mixture may not exceed 0.10 from plate samples. A binder draindown test in accordance with **AASHTO T 305** for open graded mixtures is required to be completed once per lot and may not exceed 0.50%. The acceptance test results for each sublot are required to be available after the sublot and the testing are complete.

HMA

Acceptance of HMA mixtures is done on the basis of a Type D certification submitted by the Contractor to the PE/PS on a contract. An example of this form is shown in Figure 9-4. The certification is required to be submitted with the first truck of each type of mixture each day. If no test results are available, the Contractor indicates on the form that test results are to be obtained within the first 250 tons and each subsequent 1000 tons for base and intermediate mixtures and each subsequent 600 tons for surface mixtures.

INDIANA DEPARTMENT OF TRANSPORTATION
HOT MIX ASPHALT (HMA) CERTIFICATION

CONTRACT NUMBER RS-30000 DATE 5/3/03

CERTIFIED HMA PRODUCER J.Wooden Construction

CERTIFIED HMA PLANT NUMBER 3550

DMF/ JMF NUMBER 0310075

MIXTURE TYPE AND SIZE HMA Surface,9.5 mm, Type A

DESIGN ESAL 200,000

This is to certify that the test results for Air Voids and Binder Content meet the requirements of the Standard Specifications.

Air Voids 4.3 (± 1.5 % from DMF) Binder Content 5.7 (± 0.7 % from DMF/JMF)

* [ ] Test results are not available for submittal. A production sample shall be taken within the first 250 t (250 Mg), and each subsequent 1000 t (1000 Mg) for base and intermediate mixtures and each subsequent 600 t (600 Mg) for surface mixtures.

* ✓ If Applicable

_____
Signature of HMA Producer Official

_____
Title of Official

FOR PE/PS USE ONLY

PAY ITEM(S) _____ BASIS FOR USE NO. C999998

SPECIFICATION REFERENCE

__ 304.04 - Patching	__ 402.07(c) - Temporary HMA	__ 610.02 - Approaches
__ 304.05 - Widening	__ 503.03(e) - Terminal Joints	__ 611.02 - Crossovers
__ 402.04 - HMA Pavements	__ 507.05(b) - Partial Depth Patch	__ 718.04 - Underdrains
__ 402.07(a) - Rumble Strips	__ 604.07(c) - Sidewalk	__ 801.11 - Temp.Cross.
__ 402.07(b) - Wedge & Leveling	__ 605.07(c) - Curbing	

Figure 9-4. HMA Type D Certification

SMA

Acceptance of SMA mixtures for binder content, moisture, and gradation for each sublot is based on tests conducted by INDOT. The sample locations are determined by INDOT in accordance with **ITM 802** and samples obtained from each sublot in accordance with **ITM 580.**

Test results for binder content, and gradation may not exceed the allowable tolerances of Section **401.09,** and the moisture content from plate samples may not exceed 0.10%. A binder draindown test in accordance with **AASHTO T 305** is required once per lot and may not exceed 0.30%. The acceptance test results for each sublot are required to be available after the sublot and the testing are complete.

DENSITY ACCEPTANCE

Density acceptance for QC/QA mixtures is determined from cores obtained from the compacted pavement. Two six-inch cores are required to be randomly located per sublot in accordance with **ITM 802**. The cores are taken by the Contractor and witnessed by the HMA technician. Sublot cores that are required for intermediate and base courses are required to be cored before they are covered. Surface courses are required to be cored within two work days of placement. An example of how to determine the location of the cores is shown in Figure 9-5.

The transverse core location will be no closer than 3 inches from a confined edge or 6 inches from a non-confined edge of the course being placed. The Contractor and the HMA technician are required to mark the core to designate the course to be tested. If the core indicates a course thickness less than the minimum 2.0 times the maximum particle size then the core is discarded and a new random location is selected.

The station at which a core is taken is determined using the length of pavement needed for a sublot of HMA. The transverse disatance is determined using the width of the course being placed and is measured from the right edge of the course determined by looking in the direction of increasing station numbers. Computations for the longitudinal distance are made to the nearest 1 foot and computations for the transverse distance are made to the nearest 0.1 feet. The following formula is used to calculate the length of the sublot:

$$\text{Length of Sublot (Nearest Foot)} = \frac{\text{Sublot Size (t)}}{\text{Avg. Planned Quantity (lb/yd}^2\text{)} \times \text{Width of Paving (ft)}} \times 18000$$

RANDOM SAMPLING FOR DENSITY

Contract No. R - 29233 **LOT No.** 3

District Seymour **Mixture** 25.0 mm Base

Avg. Planned Quantity 330 lb/ yd^2 **Width of Paving** 12 ft

Date Sampled: Sublot 1:5/3/05 **Sublot 2:**5/3/05 **Sublot 3:**5/4/05 **Sublot 4:**5/4/05

Sublot No.	Length of Sublot (ft)	Random Number	Random Distance (ft)	Starting Station of Sublot	Random Station	Paving Width (ft)	Random Number	Transverse Location (ft)
	A	B	A x B = C	D	C + D	E	F	E x F
1	4545	.622	2827	100+00	128+27	12	.548	6.6
	4545	.873	3698	100+00	136+98	12	.864	10.4
2	4545	.412	1863	145+45	164+08	12	.064	0.8
	4545	.777	3531	145+45	180+76	12	.356	4.3
3	4545	.127	577	190+90	196+67	12	.284	3.4
	4545	.209	950	190+90	200+40-	12	.862	10.3
4	4545	.109	495	236+35	241+30	12	.843	10.1
	4545	.757	3441	236+35	270+76	12	.283	3.4

$$\text{Length of Sublot} = \frac{\text{Sublot Size (tons)}}{\text{Avg. Planned Quantity (lb/yd}^2\text{) x Width of Paving (ft)}} \times 18000$$

Signed _____

Figure 9-5. Random Sampling for Density

Example

Sublot size	= 1000 t
Width of pavement	= 12 ft
Mixture	= 19.0 mm Intermediate
Planned quantity	= 165 lb/yd^2
Starting station of sublot	= 160 + 00
Random numbers	= .256, .561

$$\text{Length of Sublot} = \frac{1000}{165 \times 12} \times 18000$$
$$= 9090 \text{ ft}$$

$$\text{Randon Distance} = 9090 \times .256$$
$$= 2327 \text{ ft}$$

$$\text{Random Station} = (160 + 00) + (23 + 27)$$
$$= 183 + 27$$

$$\text{Transverse Distance} = 12 \times .561$$
$$= 6.7 \text{ ft} \approx 7 \text{ ft}$$

Therefore, the first core in the sublot is obtained at station 183 + 27 at a transverse distance of 7 feet from the right edge of the pavement by looking in the direction of increasing station numbers. One additional core is obtained at another random location within the sublot.

The cores are required to be handled carefully and not be left in a hot place or location where they may be damaged. If a core is damaged, a new core is obtained by INDOT. The location of the core is determined by subtracting one foot from the station of the original core using the same transverse offset.

The core holes are required to be filled with HMA with similar or smaller size particles or other approved materials within one work day of coring the holes. The Contractor is required to clean and dry the core holes before filling. The holes should be blown out with an air compressor to help the cleaning process. The Contractor's plan for refilling core holes is required to be documented in the QCP, when applicable.

Density for shoulders using QC/QA mixtures is determined from cores except where:

1) The total planned lay rate to be placed over a shoulder existing prior to the contract award is less than 385 lb/yd^2

2) The first lift of material placed at less than 385 lb/yd^2 over a shoulder existing prior to the contract award

Density of any random core location(s) in the above-noted areas is assigned a value of 92.0 % MSG and compaction is done with the specified rollers in accordance with Section **402.15**. Open graded mixtures are compacted with six passes of a static tandem roller and are assigned a value of 84.0% for % MSG. Vibratory rollers are not used on open graded mixtures.

SMOOTHNESS ACCEPTANCE

Normally, pavements are two or more lanes wide and are constructed with two or more passes of the paver. Having a finished surface with the correct grade and cross section is essential. The slope and profile to the surface are required to be checked continuously by the HMA technician.

Profiles are checked with a profilograph, a 16-foot straightedge, or a 10-foot straightedge. Slopes are checked with a 10-foot straightedge and a level.

The profilograph is required to be used where the total HMA placed is 385 lb/yd^2 or greater, and there is a design speed of greater than 45 mph on the contract. The profilograph is used on all mainline full-width pavement lanes longer than 0.1 miles and may also be specified for other pavements. The profilograph is not used the first and last 50 feet within the paving limits, 50 feet before and 50 feet after each paving exception, or on resurfacing overlays with a total design thickness of less than 385 lb/yd^2. Profilograph testing is conducted in accordance with ITM **901**.

The 16-foot straightedge is used to check profiles on all full width pavement lanes shorter than 0.1 miles, within 50 ft of a concrete reinforced bridge approach, and existing pavements, tapers, and resurfacing overlays of less than 385 lb/yd^2. The 16-foot straightedge is required to be used in areas having a design speed of 45 mph or lower, unless otherwise specified.

The 10-ft straightedge is used for checking transverse slopes, approaches, and crossovers.

Each finished lay of base and intermediate is required to be approved before placing the subsequent lay. The profile is required to be checked on the surface course and a new course placed immediately below the surface course. The location on the lane that is checked with the profilograph is as follows:

1) For lanes with traffic flow in one direction, that are less than or equal to 12 feet wide, the profilograph is operated in the direction of traffic, 3.0 ± 0.5 feet from and parallel to the right edge of each lane.

2) For lanes with traffic flow in one direction, that are greater than 12 ft wide, the profilograph is operated in the direction of traffic, 3.0 ± 0.5 feet from and parallel to both the left and the right edge of each lane.

3) For lanes with traffic flow in two directions, that are less than or equal to 12 feet wide, the profilograph is operated in the direction of increasing stations, 3.0 ± 0.5 feet from and parallel to the right edge of each lane.

4) For lanes with traffic flow in two directions, that are greater than 12 feet wide, the profilograph is operated in each direction of traffic, 3.0 ± 0.5 ft from and parallel to the edge of each lane in the direction of traffic.

The pat factors for smoothness are listed in the following table:

SMOOTHNESS	
Design Speed Greater Than 45 mph	
Profile Index in./0.1 mi.	**Pay Factor**
Over 0.00 to 0.20	1.05
Over 0.20 to 0.40	1.04
Over 0.40 to 0.80	1.02
Over 0.80 to 1.00	1.00
Over 1.00 to 1.10	0.96
Over 1.10 to 1.20	0.92
All pavement with a profile index greater than 1.20 in. shall be corrected.	

When the profilographraph is used on a surface or intermediate course, in addition to the above tolerances, any area having a high point in excess of 0.3 inches is required to be corrected. Profilograph measurements are required only on the 0.1 mile length where corrections were performed to reduce the profile index.

When the 16 foot or 10 foot straightedge is being used on an intermediate course, all areas having a high point deviation in excess of 0.2 inches are required to be corrected.

Out of tolerance sections are required to be corrected or removed, depending upon the severity of the problem. If a section of mat is required to be removed, the depth necessary to correct the deviation is determined. If the course under the surface course is exposed, then the pavement is milled 1 inch and replaced with surface. The edges of the area are required to be sawed vertically in a straight line and tacked before repaving the area.

Each finished course of base and intermediate is subject to approval before laying the subsequent course. All wavelike irregularities and abrupt changes in a profile of any course caused by paving operations are required to be corrected. If there are more than isolated instances of out of tolerance surfaces, the paving operation should be stopped until the problems are resolved.

PAY FACTORS -- QC/QA HMA

After the tests are conducted, the test data is evaluated for compliance with the Specifications. Moisture, CAA, and temperature tests are taken in accordance with standard procedures and recorded. Lot numbers begin with number 1 for each type of mixture and are continuous for the entire contract regardless of the number of adjustment periods for that type of mixture.

When the required tests for one sublot are completed, the difference between the test values and the required value on the JMF is determined and pay factors calculated. For mixtures produced during a plant's adjustment period, pay factors based on the JMF are used. A composite pay factor for each sublot is determined for the binder content, air voids @ N_{des}, VMA @ N_{des}, and density of the mixture as follows:

$$SCPF = 0.20(PF_{BINDER}) + 0.35(PF_{VOIDS}) + 0.10(PF_{VMA}) + 0.35(PF_{DENSITY})$$

where:

SCPF	=	Sublot Composite Pay Factor for Mixture and Density
PF_{BINDER}	=	Sublot Pay Factor for Binder Content
PF_{VOIDS}	=	Sublot Pay Factor for Air Voids at N_{des}
PF_{VMA}	=	Sublot Pay Factor for VMA at N_{des}
$PF_{DENSITY}$	=	Sublot Pay Factor for Density

If the SCPF for a sublot is less than 0.85, the pavement is evaluated by INDOT. If the Contractor is not required to remove the mixture, quality assurance adjustments of the sublot are assessed or other corrective actions taken as determined by INDOT.

MIXTURE

Sublot test results for mixture properties are assigned pay factors in accordance with the following:

BINDER CONTENT		
DENSE GRADED	OPEN GRADED	PAY FACTOR
Deviation from JMF (±%)	Deviation from JMF (±%)	Pay Factor
≤ 0.2	≤ 0.2	1.05
0.3	0.3	1.04
0.4	0.4	1.02
0.5	0.5	1.00
0.6	0.6	0.95
0.7	0.7	0.90
0.8	0.8	0.85
> 0.8	> 0.8	0.85-0.05 per each 0.1% over 0.8%

AIR VOIDS		
DENSE GRADED	OPEN GRADED	PAY FACTOR
Deviation from JMF (±%)	Deviation from JMF (±%)	Pay Factor
≤ 0.5	≤ 1.0	1.05
> 0.5 and ≤ 1.0	> 1.0 and ≤ 3.0	1.00
> 1.0 and ≤ 1.5	> 3.0 and ≤ 3.5	0.95
> 1.5 and ≤ 2.0	> 3.5 and ≤ 4.0	0.85
> 2.0	> 4.0	Submit to Materials and Tests Division*

* Test results will be considered and adjudicated as a failed material in accordance with normal INDOT practice as listed in 105.03.

VMA		
DENSE GRADED	OPEN GRADED	PAY FACTOR
Deviation from JMF (±%)	Deviation from JMF (±%)	Pay Factor
≤ 0.5		1.05
> 0.5 and ≤ 1.0	All	1.00
> 1.0 and ≤ 1.5		0.95
> 1.5 and ≤ 2.0		0.90
> 2.0 and ≤ 2.5		0.85
> 2.5		0.85 - 0.02 per each 0.1% over 2.5%

DENSITY

Sublot test results for density will be assigned pay factors in accordance with the following:

DENSITY		
Percentages are based on % MSG	Pay Factors – Percent	
Dense Graded	Open Graded	
≥ 97.0		Submitted to the Materials and Tests Division*
95.6 - 96.9		1.05 - 0.01 for each 0.1% above 95.5
94.0 - 95.5		1.05
93.1 - 93.9		1.00 + 0.005 for each 0.1% above 93.0
92.0 - 93.0	84.0	1.00
91.0 - 91.9		1.00 - 0.003 for each 0.1% below 92.0
90.0 - 90.9		0.97 - 0.012 for each 0.1% below 91.0
89.0 - 89.9		0.85 - 0.030 for each 0.1% below 90.0
≤ 88.9		Submitted to the Materials and Tests Division*

The following table may be used for calculating density pay factors.

DENSITY							
DENSE GRADED							
% MSG	Pay Factor	% MSG	Pay Factor	% MSG	Pay Factor	% MSG	Pay Factor
≥97.0	*	94.9	1.05	92.8	1.00	90.7	0.93
96.9	0.91	94.8	1.05	92.7	1.00	90.6	0.92
96.8	0.92	94.7	1.05	92.6	1.00	90.5	0.91
96.7	0.93	94.6	1.05	92.5	1.00	90.4	0.90
96.6	0.94	94.5	1.05	92.4	1.00	90.3	0.89
96.5	0.95	94.4	1.05	92.3	1.00	90.2	0.87
96.4	0.96	94.3	1.05	92.2	1.00	90.1	0.86
96.3	0.97	94.2	1.05	92.1	1.00	90.0	0.85
96.2	0.98	94.1	1.05	92.0	1.00	89.9	0.82
96.1	0.99	94.0	1.05	91.9	1.00	89.8	0.79
96.0	1.00	93.9	1.05	91.8	0.99	89.7	0.76
95.9	1.01	93.8	1.04	91.7	0.99	89.6	0.73
95.8	1.02	93.7	1.04	91.6	0.99	89.5	0.70
95.7	1.03	93.6	1.03	91.5	0.99	89.4	0.67
95.6	1.04	93.5	1.03	91.4	0.98	89.3	0.64
95.5	1.05	93.4	1.02	91.3	0.98	89.2	0.61
95.4	1.05	93.3	1.02	91.2	0.98	89.1	0.58
95.3	1.05	93.2	1.01	91.1	0.97	89.0	0.55
95.2	1.05	93.1	1.01	91.0	0.97	88.9	*
95.1	1.05	93.0	1.00	90.9	0.96		
95.0	1.05	92.9	1.00	90.8	0.95		
OPEN GRADED							
84.0 -- 1.00							

* Requires submittal to Materials and Tests Division for Failed Material Investigation

Example

A 25.0 mm Base mixture has the following test results. Determine the Quality Assurance Adjustments for each sublot.

Sublot 1 = 1000 tons
Sublot 2 = 1000 tons
Sublot 3 = 1000 tons
Sublot 4 = 1000 tons

Unit Price = $28.00/ton

MAF = 1.000

JMF % Binder = 4.2 %
Air Voids = 4.0 %
VMA = 12.5 %

	Sublot 1	Sublot 2	Sublot 3	Sublot 4
% Binder	4.5	4.6	4.8	4.2
Air Voids	3.8	3.7	3.2	4.7
VMA	12.2	12.1	11.6	13.4
Density (% MSG)	91.1	90.7	89.9	92.9

Deviations for JMF % Binder, Air Voids, and VMA:

	Sublot 1	Sublot 2	Sublot 3	Sublot 4
% Binder	0.3	0.4	0.6	0.2
Air Voids	0.2	0.3	0.8	0.7
VMA	0.3	0.4	0.9	0.9

Using the pay factor charts, the following values are obtained:

	Sublot 1	Sublot 2	Sublot 3	Sublot 4
% Binder	1.04	1.02	0.95	1.05
Air Voids	1.05	1.05	1.00	1.00
VMA	1.05	1.05	1.00	1.00
Density (% MSG)	0.97	0.93	0.82	1.00

Calculations to determine the Quality Assurance Adjustment are shown in Figure 9-5.

INDIANA DEPARTMENT OF TRANSPORTATION

HOT MIX ASPHALT ANALYSIS FOR QUALITY ASSURANCE

CONTRACT NO. _____ PLANT NO. _____ LOT NO. _____ DATE _____

MIXTURE _____ DMF/JMF NO. _____

Mixture & Density	SUBLOT 1			SUBLOT 2			SUBLOT 3			SUBLOT 4		
	Pay Factor	Mult		Pay Factor	Mult		Pay Factor	Mult.		Pay Factor	Mult.	
% Binder	1.04	0.20	0.2080	1.02	0.20	0.2040	0.95	0.20	0.1900	1.05	0.20	0.2100
Air Voids	1.05	0.35	0.3675	1.05	0.35	0.3675	1.00	0.35	0.3500	1.00	0.35	0.3500
VMA	1.05	0.10	0.1050	1.05	0.10	0.1050	1.00	0.10	0.1000	1.00	0.10	0.1000
Density	0.97	0.35	0.3395	0.93	0.35	0.3255	0.82	0.35	0.2870	1.00	0.35	0.3500
SCPF			1.02			1.00			0.93			1.01

* Requires submittal to the Materials and Tests Division for Failed Material Investigation

QUALITY ASSURANCE ADJUSTMENTS							
Sublot 1 Quantity L (tons)	Sublot 1 Adjustment ($)	Sublot 2 Quantity L (tons)	Sublot 2 Adjustment ($)	Sublot 3 Quantity L (tons)	Sublot 3 Adjustment ($)	Sublot 4 Quantity L (tons)	Sublot 4 Adjustment ($)
1000	+560.00	1000	0	1000	-1960.00	1000	+280.00

U = Unit Price for Material, $/Ton

Quality Assurance Adjustment = L x U x (SCPF – 1.00) / MAF

Figure 9-5. Quality Assurance Adjustment

MIX APPEAL -- QC/QA HMA

If the Contractor does not agree with the acceptance test results, a request may be submitted in writing that additional tests be made. The written request includes the Contractor's test results and is made within seven calendar days of receipt of the written results of the HMA tests for that lot. The appeal is not accepted if the Contractor has not conducted any tests that indicate a lower Pay Factor than was determined from the test results by INDOT.

Additional tests for the appeal may be requested for the maximum specific gravity, bulk specific gravity of the gyratory specimens, binder content, or bulk specific gravity of the density cores. One or more of these tests may be requested for the sublot or the entire lot. Upon approval of the appeal, the backup samples are tested as follows:

1) Maximum Specific Gravity -- The sample is dried in accordance with **ITM 572** and tested in accordance with **AASHTO T 209**, Section 9.5.1.

2) Bulk Specific Gravity of the Gyratory Specimens -- New gyratory specimens are prepared and tested in accordance with **AASHTO T 312**.

3) Binder Content -- The binder content is tested in accordance with the test method that was used for acceptance.

4) Bulk Specific Gravity of the Density Core -- Additional cores are taken within seven calendar days unless otherwise directed. The core locations are determined by adding 1.0 foot longitudinally of the cores tested for acceptance using the same transverse offset. The cores are tested in accordance with **AASHTO T 166**.

The appeal results replace all previous test result(s) for acceptance of the mixture properties and density.

ADJUSTMENT QUANTITY -- QC/QA HMA

The pay factors are used to calculate a quality assurance adjustment quantity (q) for the sublot. The adjustment for mixture properties and density is calculated as follows:

$$q = L \times U \times (SCPF - 1.00)/MAF$$

where:

q = quality assurance adjustment for the sublot
L = sublot quantity
U = unit price for the material, $/Ton
SCPF = sublot composite pay factor

The total quality assurance adjustments are calculated as follows:

$$Q = Qs + (\Sigma\, q)$$

where:

Q = total quality assurance adjustment
Qs = quality assurance adjustment for smoothness as calculated in Section **401.19(c)**
q = sublot quality assurance adjustment

ADJUSTMENT QUANTITY -- SMA

The adjustment points are used to calculate a quality assurance adjustment quantity (q) for the sublot. The adjustment for mixture properties and density is calculated as follows:

$$q = (L \times U \times P/100)/MAF$$

where:

q = quality assurance adjustment quantity
L = lot quantity
U = unit price for material, $/TON
P = total adjustment points

The total quality assurance adjustments are to be calculated as follows:

$$Q = Q_s + 3\,(q_m + q_d)$$

where:

Q = total quality assurance adjustment quantity
Q_s = quality assurance adjustment for smoothness as calculated in Section **401.19(c)**
q_m = lot adjustments for mixtures
q_d = lot adjustments for density

MIXTURE ADJUSTMENT FACTOR

A Mixture Adjustment Factor (MAF) is used to adjust the mixture planned quantity and lay rate prior to paving operations, and the pay quantity upon completion of production of the mixture. The MAF is calculated by dividing the maximum specific gravity (G_{mm}) from the mixture design by the following values:

Mixture		
9.5 mm	--	2.465
12.5 mm	--	2.500
19.0 mm	--	2.500
25.0 mm	--	2.500

If the calculated MAF is equal to or greater than 0.980 and equal to or less than 1.020 then the MAF value shall be considered to be 1.000. If the calculated MAF is less than 0.980 or greater than 1.020 then the MAF shall be the actual calculated value. The planned quantity and lay rate are adjusted by multiplying by the MAF. The accepted quantity for payment is adjusted by dividing by the MAF.

Example

Mixture	=	9.5 mm Surface
Planned Quantity	=	9,750.00 tons
Payment Quantity	=	9,500.00 tons
Mix Design G_{mm}	=	2.360
Lay Rate	=	165 lb/yd^2

$$MAF = \frac{2.360}{2.465} = 0.957$$

Adjusted Planned Quantity = 0.957 x 9750.00 = 9,330.75 tons

Adjusted Lay Rate = 0.957 x 165 lb/yd^2 = 158 lb/yd^2

$$\text{Adjusted Pay Quantity} = \frac{9500.00}{0.957} = 9{,}926.85 \text{ tons}$$

The MAF does not apply to open graded mixtures.